Application

for

United States Patent

To all whom it may concern:

Be it known that John DiDomenico and Paul F. Kyle have invented certain new and useful improvements in

METHOD AND SYSTEM FOR VIDEO CAPTURE OF VEHICLE INFORMATION

of which the following is a full, clear and exact description:

METHOD AND SYSTEM FOR VIDEO CAPTURE OF VEHICLE INFORMATION

FIELD OF THE INVENTION

[0001] The present invention relates generally to video capture devices. More particularly, the present invention relates to a method and system for capturing, storing, and transmitting visual images of elements of vehicles for use in connection with emissions data collection, law enforcement, and/or transportation systems planning.

BACKGROUND OF THE INVENTION

[0002] The collection of visual images of vehicles as they move along a roadway has been found to be useful in an increasing number of applications. For example, the collection of visual images of vehicle license plates, along with images of vehicle types and/or colors, is useful in law enforcement to identify vehicles that exceed a speed limit and/or who otherwise violate traffic-related laws. When used in conjunction with other information, such as emissions data, vehicle inspection due dates, and other information, such images can be used to determine an individual vehicle's compliance with requirements such as emission requirements and inspection requirements. Such data can also be used for transportation systems planning. For example, the number of vehicles passing by a particular point over a time period may be collected, and such data may be compared to the visual images to determine the types of such vehicles, whether such vehicles exhibit in-state or out-of-state license plates, or other information. The prior art systems that provide for video capture of vehicle related information typically comprise analog video cameras

placed along or near the side of a road. Such analog cameras feed collected visual images into a video capture card, which must be triggered, using software, to freeze the frame and commit the visual image into memory. The image is preferably digitized and compressed so that a larger number of images can be stored in a smaller amount of memory.

[0003] In some compression techniques, and especially techniques that start with analog images, the method of compression often results in degradation or loss of part of the original video image. In such a situation, if the license plate number and/or state is not legible in the stored image, the image cannot be used. In addition, many applications require more than just a license plate number, such as information relating to vehicle manufacturer, color, and/or type, which are all additional items of information which can be lost in the compression process.

[0004] In addition, the method of using an analog camera and capture board is expensive, as many pieces of equipment are required to accomplish the result. Further, many of the prior art video capture cards generally can handle only one camera. Accordingly, they are not desirable in applications where multiple cameras are required, such as in areas where multiple cameras are used to collect data across multiple lanes of a roadway.

[0005] Accordingly, it is desirable to provide an improved method and system for the capture of visual information relating to vehicles traveling on a roadway.

SUMMARY OF THE INVENTION

[0006] It is therefore a feature and advantage of the present invention to provide a novel video capture system as herein disclosed In accordance with one embodiment of the present invention, a system for managing visual images of vehicles includes a first digital video image collector positioned to capture a first data file that is representative of a visual image of at least one feature of a first vehicle moving on a roadway, The first digital video image collector includes: (1) a first communications port; (2) a computing device having a processor, a memory, and (3) a second communications port; a first communications link between the first communications port and the second communications port. A first information collection device is in communication with the computer and positioned to capture speed, acceleration, and/or emissions data corresponding to the first vehicle. Preferably, the first communications port an/or the first communications link is capable of transferring data at a transfer rate substantially equal to at least one of 100, 200, and 400 megabits per second and/or substantially complies with the Institute for Electrical and Electronics Engineers (IEEE) 1394 Standard for a High Performance Serial Bus. vehicle.

[0007] Optionally, the system also includes a second digital video image collector positioned to capture a second data file that is representative of a visual image of at least one feature of a second vehicle moving on a roadway. The second digital camera includes a third communications port and a second communications link between the third communications port and the first digital video image collector. Preferably, the second information collection device is further positioned to capture at least one of speed, acceleration, and emissions data corresponding to the second vehicle. Also preferably, this system includes a second information collection device positioned to capture at least one of speed,

acceleration, and emissions data corresponding to the second vehicle. The third communications port and/or the third communications link should be capable of transferring data at a transfer rate substantially equal to at least one of 100, 200, and 400 megabits per second, and it should substantially comply with the IEEE 1394 Standard for a High Performance Serial Bus.

[0008] Optionally, the system also includes an illumination source positioned to provide illumination directed to the at least one feature of the first vehicle.

[0009] In accordance with an alternate embodiment, a method of capturing and managing vehicle images includes the steps of: (1) using a first video capture device to collect a first digital image of at least one feature of a first vehicle; (2) using a data collection device to collect first data representative of at least one of speed, acceleration, and emissions of the first vehicle; and (3) delivering the first digital image and the first data to a computer program memory via at least one communications link. Preferably, the delivering step is performed at a transfer rate substantially equal to at least one of 100, 200, and 400 megabits per second, and/or it is the delivering step is performed via a serial connection that substantially complies with the IEEE 1394 Standard for a High Performance Serial Bus.

[0010] There have thus been outlined the more important features of the invention in order that the detailed description thereof that follows may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described below and which will form at least part of the subject matter of the claims appended hereto.

[0011] In this respect, before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and to the arrangements of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein, as well as the abstract included below, are for the purpose of description and should not be regarded as limiting in any way.

[0012] As such, those skilled in the art will appreciate that the concept and objectives, upon which this disclosure is based, may be readily utilized as a basis for the design of other structures, methods and systems for carrying out the several purposes of the present invention. It is important, therefore, that the claims be regarded as including such equivalent constructions insofar as they do not depart from the spirit and scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 illustrates an exemplary embodiment of the present inventive video capture system in connection with a system for capturing other information related to one or more vehicles.

[0014] FIG. 2 is a block diagram that illustrates several hardware elements of a preferred embodiment of the present invention.

[0015] FIG. 3 is a block diagram that illustrates several hardware elements of an alternative embodiment of the present invention.

[0016] FIG. 4 is a flow chart illustrating the steps that a preferred embodiment of the present inventive system may follow to capture and manage visual images.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

[0017] A preferred embodiment of the present invention provides an improved method and system for capturing and managing video images corresponding to one or more features of a vehicle or vehicles in connection with other data relating to the vehicle or vehicles. A preferred embodiment of the present inventive system is illustrated in FIG. 1. Referring to FIG. 1, a first digital video capture device **10** is positioned along, near, or over a roadway and is positioned to capture a digital image of one or more features of a vehicle **24**. Such features preferably include the vehicle's license plate number and state, and they may also include additional features, such as vehicle make, model, color, registration date, and/or inspection sticker data. Preferably, the position of the video capture device provides a skew angle to the vehicle features of not more than approximately 30 degrees. Other angles may be used, but they may not provide picture qualities that are as desirable as those within the range.

[0018] The video capture device **10** includes a first communications port **12** that delivers the digital image via a communications link **22** to a computing device **16** having a second communication port **36** that receives the digital image. The computing device **16** includes, at a minimum, a processor and memory, and the communications link **22** may be a cable, a wireless medium, a bus, or any other medium for communication. An information collection device **18** is in communication with computer **16**. The information collection device **18**

is also positioned along, near, or over or under a roadway to collect vehicle information such as emissions data, speed, and/or acceleration. Such data is also delivered to the computing device **16**. In the exemplary illustration of FIG. 1, the information collection device **18** is an open path emission sensor that, in conjunction with a reflection unit **19**, detects one or more components of the vehicle's exhaust.

[0019] Although the exemplary illustration in FIG. 1 shows the computing device **16** being housed in the same unit as the information collection device **18** and separate from the first video capture device **10**, other embodiments are possible. For example, the computing device **16** may be housed within the video capture device **10**, in which case the communications link **22** between the video capture device **10** and computing device **16** will be included within the video capture device **10**. In addition, the information collection device **18** may also be housed within the same unit as the video capture device **10**. In such an embodiment, the video capture device is preferably positioned to capture the image after the vehicle passes the device, and thus a timer to provide a delay between information collection and video capture may be provided.

[0020] In any of the embodiments, the communications link **22** is capable of transferring data at a transfer rate that substantially complies with the IEEE 1394-1995 Standard for a High Performance Serial Bus. (IEEE 1394). The IEEE 1394 standard provides for the transport of data at speeds substantially equal to 100, 200, or 400 megabits per second. In addition, because the interface is digital, there is no need to convert the digital data into analog data. Accordingly, the interface results in little or no loss of data integrity, thus substantially or completely eliminating the disadvantage of data loss associated

with compression. The transfer may be performed via either asynchronous or isochronous transport. Using asynchronous transport, the data request is sent to a specific address, and an acknowledgement is returned. Using isochronous transport, data is transported at a predetermined rate, thus eliminating the need for buffering of the data. As used herein, the term IEEE 1394 and the phrase IEEE 1394-1995 Standard for a High Performance Serial Bus are intended to apply to the original standard, which was published in 1995, along with existing amendments and future amendments to the standard, such as the amendment known as IEEE 1394a–2000, so long as such standards provide for transfer of data at a rate substantially equal to 100, 200, and/or 400 megabits per second.

[0021] Referring again to FIG. 1, the video capture device **10** and/or the computing device **16** may include a transmitter such as **14** or **20** that may be used to transmit the captured video images and other data to another device. Such transmitters may be wireless transmitters, direct wired outputs, or any other device. In the alternative, instead of a transmitter, the video capture device **10** and/or the computer device **16** may include a portable memory unit such as a floppy disk, CD-R, ZIP drive, or other device onto which video images and other vehicle data may be downloaded and removed for viewing and/or analysis on another computing device.

[0022] FIG. 1 also illustrates and alternative embodiment of the present invention wherein a second video capture device **26** is positioned to receive digital visual images or a second vehicle **34** in the roadway. In accordance with this embodiment, the first video capture device **10** may be positioned to capture images of vehicles travelling in one lane of a roadway, while the second device may be positioned to capture images relating to vehicles

travelling in another lane of the roadway. The second video capture device **26** also includes a communications port **28** that is in communication with the first video capture device **10** via a communications link **30**. The communications link **28** and communications link **30** also substantially comply with the IEEE 1394 standard in that they are capable of transferring data at a transfer rate substantially equal to 100, 200, and/or 400 megabits per second. The cameras are connected in a series or "daisy chain" format, which allows for data to be managed by a single or few cameras in accordance with the IEEE 1394 standard, and thus each video capture device need not contain all of the hardware required to manage the data.

[0023] In addition to the second video capture device **26** illustrated in FIG. 1, additional video capture devices may be connected in a series or "daisy chain" format, all of which are connected using the IEEE 1394 standard or another standard capable of transmission via transfer rates of 100, 200, and/or 400 megabits per second. Optionally and preferably, the cameras, information collectors, illumination sources, and other components are housed in one or more weatherproof boxes.

[0024] Optionally, the system may include an illumination source such as **11** or **27** to allow the image collector to obtain images at night. Preferably, the source is an infrared source, such as a source in the near-visual spectrum, to provide illumination without distracting drivers. Also optionally, a light sensor may be provided to automatically turn the illumination source on and off when required.

[0025] The IEEE 1394 standard, also known as FireWire, provides capability for the processor and memory to operate using one of numerous

operating systems. Such operating systems may include MAC OS, Windows CE, Windows 2000 or 9x, Windows NT, Linux, or any other operating system. Preferably, a preferred embodiment of the present invention uses a Windows CE or Windows CE-compatible operating system.

[0026] Preferably, once an image of the vehicle is taken, the picture is analyzed, using a machine visioning or pattern recognition technology, to identify the vehicle feature or features that are desired. For example, if a license plate is the desired feature to be recognized, the analysis may identify the vehicle's license plate. The image of this desired feature may then be stored in a memory separate and apart from the entire image, thus saving memory space. Preferably, the desired portion of the image (such as a license plate) is stored and/or transmitted in an uncompressed format to preserve image quality, while the remainder of the image, if stored or transmitted at all, is done in a compressed format (such as a JPEG format). Optionally, however, the entire image or a portion of the image may be stored in a computer memory, either before or after transmission, either in compressed or uncompressed format.

[0027] FIG. 2 illustrates exemplary internal hardware elements of many of the devices illustrated in FIG. 1. Referring to FIG. 2, a video capture device **50** includes a serial bus **53** that links a video capture unit **54**, such as a digital camera, digital video camera, or other capture device, to a communications port **52**. Additional elements, such as drivers and/or encoders, optionally may be placed between the video capture unit **54** and bus **53** and/or communications port **52** and bus **53**. In addition, a computing device **40** contains a serial bus **42** that links internal computer features such as a processor **44**, a memory **46**, and a communications port **48**. As with the video capture device, additional elements

such as drivers and/or encoders may be included between the bus **42** and other elements of the computer **40**.

[0028] The communications port **48** of the computer **40** and the communications port **52** of the video capture device **50** are linked via a communications link **60**. The communications link **60** may be a direct wire or a wireless medium. The communications ports and communications link transfer data at rates substantially equal to 100, 200, and/or 400 megabits per second.

[0029] Another input device **49** may be included with the computer **40** to collect other information relating to the vehicle identified by the video capture device **50**, such as emissions data, vehicle speed, and/or vehicle acceleration. The other capture device **49** may be included with the computer **40**, or, in the alternative or in addition to having a capture device within the computer, an external capture device **56** may communicate with the computer **40** via the communications port **48** or a different communications port. It is preferable, but not necessary for the present invention, that the communications link **58** between the device used to capture emissions, speed, and/or acceleration data and the computer also comply with the IEEE 1394 standard.

[0030] FIG. 3 illustrates an alternative embodiment of the present invention wherein the video capture device and computing elements are included within the same housing. Referring to FIG. 3 a housing **70** includes a video capture unit **74** such as a digital video camera or digital camcorder, a processing device **76** and a computer memory **78**. All of these features are linked by a high speed serial bus **72** that substantially complies with the IEEE 1394 standard so that digital images collected by the video capture device **74** may be transferred to the memory **78** and/or the processor **76** at high rates of speed, preferably at rates

substantially equal to 100, 200, and/or 400 megabits per second. The unit also contains a communications port **80** that may be used to transmit data to an external device. In the alternative, or in addition to the communications port **80**, a device such as a floppy disk, recordable CD, ZIP drive or other device may be used to store and transport the data collected by the video capture device **74**. Additional elements, such as drivers and/or encoders, may be included between the bus **72** and any of the other items described above.

[0031] Another capture element **82** may optionally be included within the housing **70** to capture other vehicle-related data, such as speed, acceleration, and/or emissions data. In addition to having another capture device within the housing **70** or in the alternative, an additional capture device **84** may be positioned external to the housing **70** and include a communications link **86** that may be used to transfer data captured by the other capture device **84** to the memory **78** or processor **76** via a communications port **80** and serial bus **72**. As with the embodiment illustrated in FIG. 2, it is not necessary that the communications link **86** between the other capture device **84** and communications port **80** comply with the IEEE 1394 standard.

[0032] FIG. 4 is a block diagram that illustrates the steps that the method embodiment of the present invention may follow to capture video image and other data relating to a vehicle and manage such data. Referring to FIG. 4, a first digital image is collected (step **90**) of a first vehicle. In addition, data relating to the same vehicle, such as the vehicle's speed, acceleration, and/or emissions are also collected by a sensing device such as an emissions sensor, speed sensor, laser, or other tracking device (step **92**). Optionally, a second video capture device may collect a second digital image of a second vehicle (step **94**).

Second data relating to the second vehicle, such as speed, acceleration, and/or emissions data may also be collected (step **96**) by the same information collection device, or a second information collection device may be trained to collect the data from the second vehicle. The images and data collected relating to each vehicle are preferably stored in a memory (step **98**) and the delivery of the images will be performed via a communications link at a transfer rate substantially equal to 100, 200, and/or 400 megabits per second. Optionally, the images and/or data may be transmitted to an external location (step **100**) and/or downloaded to a device such as a floppy disk, CD-recordable, and/or ZIP drive.

[0033] The many features and advantages of the invention are apparent from the detailed specification, and thus, it is intended by the appended claims to cover all such features and advantages of the invention which fall within the true spirit and scope of the invention. Further, since numerous modifications and variations will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation illustrated and described, and accordingly, all suitable modifications and equivalents may be resorted to, all of which may fall within the scope of the invention.